The invention claimed is:

1. An analyzer comprising:

a combustion furnace for receiving samples for combustion;

a combustion detector coupled in a flow path of byproducts of combustion from said combustion furnace for determining when combustion is completed;

a variable volume ballast chamber coupled to the flow path of combustion byproducts for receiving byproducts of combustion until combustion has been completed, said variable volume ballast chamber including a movable piston and a sensor for detecting the position of said piston; and

a control coupled to said sensor for the detection of the position of the piston and calculating a volume correction factor for the concentration of gases of the byproducts of combustion based upon the position of said piston.

2. The analyzer as defined in claim 1 wherein said combustion detector detects CO_2.

3. The analyzer as defined in claim 1 wherein said combustion detector detects H_2O.

4. The analyzer as defined in claim 1 wherein said variable volume ballast chamber comprises a cylindrical container and said sensor is a rotary encoder coupled to said piston by a cable.

5. The analyzer as defined in claim 4 wherein said cylindrical container has a sample gas inlet and a sample gas outlet at one end and a first control valve associated with said inlet and a second control valve associated with said outlet to control the entry and exit of sample gas into said variable volume ballast chamber.

6. The analyzer as defined in claim 5 wherein said cylindrical container includes a fluid inlet at an end opposite said one end and on a side of said piston opposite said sample gas inlet and a fluid control valve coupled to a source of pressurized fluid to selectively move said

piston to force sample gas from said variable volume ballast chamber through said sample gas outlet.

7. The analyzer as defined in claim 6 wherein each of said first, second and fluid control valves are coupled to said control for sequentially actuating said valves to introduce sample gas into said variable volume ballast chamber, allow said sample gas to equilibrate in said variable volume ballast chamber, and subsequently discharge sample gas from said variable volume ballast chamber.

8. The analyzer as defined in claim 7 wherein a H_2O sensor is coupled to said gas outlet of said variable volume ballast chamber to detect the concentration of H_2 during an analysis.

9. The analyzer as defined in claim 7 wherein a CO_2 sensor is coupled to said gas outlet of said variable volume ballast chamber to detect the concentration of C during an analysis.

10. A method of determining the concentration of elemental elements in a sample including the steps of:

combusting a sample;

collecting the byproduct gases of combustion in a variable volume ballast chamber;

detecting the completion of combustion; and

measuring the volume of gases collected by the variable volume ballast chamber upon completion of combustion.

11. The method as defined in claim 10 wherein said collecting step comprises introducing byproduct gases of combustion into a sample gas inlet in a container having a movable piston such that said piston moves in response to the introduction of byproduct gases of combustion until combustion has been completed as determined by said detecting step.

12. The method as defined in claim 11 wherein said collecting step further includes sequentially actuating an inlet valve associated with said sample gas inlet and an outlet valve

associated with a sample gas outlet in said container to introduce and capture byproduct gases of combustion.

13. The method as defined in claim 12 wherein said collecting step further includes actuating a control valve coupled to a fluid inlet in said container on a side of said piston opposite said sample gas outlet for supplying pressurized fluid to said piston to force byproduct gases of combustion from said container.

14. The method as defined in claim 13 wherein said collecting step further includes allowing a period of time sufficient for said byproduct gases of combustion to equilibrate before forcing said byproduct gases of combustion from said container.

15. The method as defined in claim 14 wherein said detecting step comprises detecting CO_2 in a stream of said byproduct gases of combustion before introduction into said container.

16. The method as defined in claim 10 wherein said measuring step comprises sensing the position of said piston.

17. The method as defined in claim 16 wherein said sensing step comprises coupling said piston to an encoder through a cable such that as said piston moves said encoder provides information as to the piston position which corresponds directly to the volume of collected byproduct gases of combustion.

18. The method as defined in claim 10 and further providing a volume correction factor for the determination of the concentration of an element according to the formula:

$$V_{CF} = \frac{Vd}{Vs}$$

where Vd is the detected volume after combustion based upon the movement of the piston; and
Vs is the volume under a standardized known condition.

19. The method as defined in claim 10 and further including detecting the pressure of collected byproducts of combustion in said variable volume ballast chamber.

20. The method as defined in claim 19 and further providing a pressure correction factor for the determination of the concentration of an element according to the formula:

$$P_{CF} = \frac{Pd}{Ps}$$

where Pd is the detected pressure after combustion; and

Ps is the pressure under a standard known condition.

21. A variable volume ballast chamber for the collection of byproducts of combustion comprising:

a container having an interior wall and a movable piston positioned in said container in sealed engagement with said interior wall;

said container including a sample gas inlet on one side of said piston and said inlet is coupled to an inlet valve;

a sensor coupled to said piston for detecting the position of the piston;

said container including a sample gas outlet on said one side of said piston, said sample gas outlet coupled to an outlet control valve; and

said container including an inlet positioned on the opposite side of said piston for receiving a pressurized fluid for moving said piston to expel collected gases through said sample gas outlet upon application of pressure to said opposite side of said piston.

22. The variable volume ballast chamber as defined in claim 21 wherein said container is cylindrical and includes sealed plates at opposite ends and wherein said sample gas inlet and said sample gas outlet are each formed in one of said sealed plates.

23. The variable volume ballast chamber as defined in claim 22 wherein said sensor is a rotary encoder coupled to said piston by a cable.

24. The variable volume ballast chamber as defined in claim 23 wherein said rotary encoder is mounted to the other of said sealed plates.

25. The variable volume ballast chamber as defined in claim 24 wherein said rotary encoder is mounted to a side of said other of said sealed plates opposite said piston and wherein said other of said sealed plates includes an aperture for coupling said cable to said rotary encoder, and further including a sealing cap sealably positioned over said rotary encoder and wherein said inlet for said pressurized fluid extends through said sealing cap.

26. An elemental analyzer for the determination of the concentration of at least carbon and nitrogen comprising:

a combustion furnace for receiving organic samples for combustion;

a combustion detector coupled to said furnace for receiving byproducts of combustion from said combustion furnace for determining when combustion is completed;

a variable volume ballast chamber coupled to said combustion furnace for receiving byproducts of combustion, said variable volume ballast chamber including a movable piston; and

a control coupled to said combustion detector for the detection of the completion of combustion and sealing byproducts of combustion in said variable volume ballast chamber when combustion is completed.

27. The analyzer as defined in claim 26 wherein said variable volume ballast chamber includes a sample gas inlet and a sample gas outlet on one side of said piston and said control includes valves coupled to said inlet and to said outlet for selectively capturing byproducts of combustion in said variable volume ballast chamber.

28. The analyzer as defined in claim 26 wherein said combustion detector detects CO_2.

29. The analyzer as defined in claim 26 wherein said combustion detector detects H_2O.

30. The analyzer as defined in claim 26 and further including a sensor for detecting the position of said piston and wherein said control includes a CPU for calculating a volume correction factor for the concentration of gases of the byproducts of combustion based upon the position of said piston.

31. The analyzer as defined in claim 30 wherein said variable volume ballast chamber comprises a cylindrical container having a sample gas inlet and a sample gas outlet on one side of said piston and an inlet valve coupled to said inlet and an outlet valve coupled to said outlet.

32. The analyzer as defined in claim 31 wherein said cylindrical container includes a fluid inlet on an opposite side of said piston and a fluid control valve coupled to a source of pressurized fluid to selectively move said piston to force sample gas from said variable volume ballast chamber through said sample gas outlet.

33. The analyzer as defined in claim 32 wherein each of said valves are coupled to said CPU for sequentially actuating said valves to introduce sample gas into said variable volume ballast chamber, allow said sample gas to equilibrate in said variable volume ballast chamber, and subsequently discharge sample gas from said variable volume ballast chamber.

34. The analyzer as defined in claim 33 wherein a H_2O sensor is coupled to said gas outlet of said variable volume ballast chamber to detect the concentration of H_2 during an analysis.

35. The analyzer as defined in claim 33 wherein a CO_2 sensor is coupled to said gas outlet of said variable volume ballast chamber to detect the concentration of C during an analysis.